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Numerical methods for simulation of heating through electromagnetic induction.

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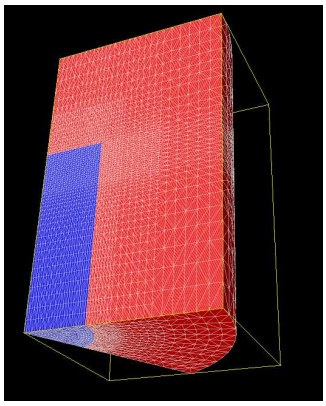
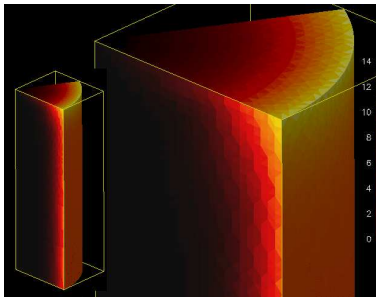
The Telluride Code Project is tasked to develop and apply a new simulation tool designed to model and optimize the gravity-pour casting processes which are currently ongoing at LANL foundries in support of the U.S Department of Energy (DOE) alloy manufacturing needs. The Telluride simulation tool must accurately model the entire alloy casting process in one integrated simulation. This process begins with molten alloy free surface flow characteristic of the pouring and filling of a mold cavity. Cooling and solidification of the alloy follows shortly thereafter, followed by a more gradual cooling of the solid alloy to room temperature, which completes the casting process. Further homogenization heat treatment and machining prepare the alloy part for integration into the engineering system for which it is designed.

This work comes out of the development of an electromagnetic modeling capability for the Telluride project's materials processing/metal casting simulation tool Truchas. Of particular importance is the simulation of the heating of heavy metals and graphite mold and filling structures through electromagnetic induction.

Here we present numerical results for modeling of following problem. Finite-length graphite cylinder exposed to an external, alternating magnetic field directed along its axis. The sinusoidally varying field induces an azimuthal current near the surface of the cylinder, which because of the finite conductivity, dissipates energy in the form of a Joule heat in the graphite. Symmetry is exploited by modeling only a 60-degree wedge of the top half of the cylinder.



The computational domain and grid (200K tets). The blue region is the graphite cylinder, and the red region is free space.



The average of the Joule heat in the graphite cylinder over a cycle of the external field. This is the effective heat source that is used to model the heat conduction.

Acknowledgements

Los Alamos Report LA-UR-04-0721. Funded by the Department of Energy under contracts W-7405-ENG-36 and the DOE Office of Science Advanced Computing Research (ASCR) program in Applied Mathematical Sciences. Funded by the ASCI program in the Department of Energy under contracts W-7405-ENG-36.